COMPATIBLE INFLUENCE OF NP FERTILIZERS AND INDOLE ACETIC ACID WITH DIFFERENT DOSES ON COARSE RICE (*ORYZA SATIVA* L.)

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ABSTRACT

An experiment was launched to determine the response of Rice (Oryza sativa L.) to Nitrogen-Phosphorous (NP) levels and Indole acetic acid (IAA) at the agronomic research area, Faculty of Agriculture, Gomal University, during summer 2016. The experiment was laid out in Randomized Compete Block Design with split plot arrangement. Three fertilizer doses of Nitrogen and the Phosphorous (40 kg ha^{-1}, 80 kg ha^{-1} and 120 kg ha^{-1}) along with control were kept in main plots. There were three doses of IAA (40 ml ha^{-1}, 80 ml ha^{-1} and 120 ml ha^{-1}) with control and which were kept in one sub-plot. The effect of both applications (Nitrogen-Phosphorous & Indole acetic acid) in rice shown significant results about plant height, number of panicles m^{-2}, spikelet $spike^{-1}$ and number of kernels $spike^{-1}$, 1000-grain weight, paddy yield and BCR. The fertilizer dose of NP @ 80 kg ha^{-1} produced higher paddy yield of 4.90 tonnes ha^{-1} followed by fertilizer dose of NP @ 120 kg ha^{-1} with paddy yield of 4.70 tonnes ha^{-1}. A higher yield of 4.95 tonnes ha^{-1} was produced when Indole acetic acid was applied @ 80 ml ha^{-1} which was followed by IAA @ 40 ml ha^{-1} having yield of 4.50 tonnes ha^{-1}. The interaction among fertilizer and plant growth also showed significant effect on yield and yield contributing factors. Maximum benefit can be achieved when Indole acetic acid was applied @ 80 ml ha^{-1} with fertilizer dose of Nitrogen and Phosphorous @ 80 kg ha^{-1}.

Keywords: *Rice yield, Indole Acetic Acid & NP Fertilizer*

INTRODUCTION

Rice is at second level of staple food in Pakistan and main source of foreign income of the country. Rice is major cereal crop which is used by 60 % people as a source of food in Pakistan. Rice is chiefly used as fodder worldwide in the winter (Drake, Nader & Forero, 2002). Pakistan is a country which is forth largest producer of rice and 30% supply of rice in the worldwide comes from Pakistan (Anonymous, 2017a). Rice contributed up to 6% in agriculture and 0.6 % in the GDP and great recorded production of rice 6838 thousand tonnes was achieved in this year having an increment 0.7% over last year's production of 6801 thousand tons (Anonymous, 2017b). Rice production is of prime importance in a country like Pakistan. Therefore, some integrated approaches should be introduced to cope with hazard to rice production. Rice productivity can be sustained or enhanced by integrated use of plant hormone with fertilizers. Plant hormone can be used for various aspects on the different growth levels and many plant hormones interrelate with each other for grain yield production. Minor concentrations of plant hormone can improved the physiological growth of plant and which can be resulted in higher grain yield (Sajid, Amin, Ahmad & Khan, 2016). Auxins can

be assumed as the most significant growth hormones which positively affects the growth patterns of plant in an organized way (Evans, Sharp & Flick, 1981; Vasil & Thorpe, 1994).

LITERATURE REVIEW

Indole acetic acid (IAA) is very common plant hormone belonged to auxin's class and synthesized by plants and artificially applied (Simon & Petrasek, 2011). Indole acetic acid (IAA) is principal essential main auxin in plant which controls the various physiological processes like division, enlargement of cells, tissue differentiation and movement of plant parts due to light or gravity (Hussain, Hussain, Nawaz & Bhatti, 2011). Plant flowering and other physiological processes are greatly modified by Indole acetic acid (Khan & Chaudhary, 2010). The exogenous treatments of Indole Acetic Acid behave like natural occurring and can be proved helpful for determining plant influence of artificially applied IAA on plants to determining growth attributes of plants (Davis, 1995). It also works to overcome stress conditions. It has been noticed that there was found a low concentration of IAA in the leaves which are highly responsive to external stress conditions (Xie, Jiang, Cao, Dai & Jing, 2003). In stress conditions, IAA played the role in plant to synthesize more carbohydrates, amino acids and proteins which are essential to regulate growth of plants (Agarwal & Gupta, 1995).

Rice yield could affected with the declining the soil fertility and imbalanced use of fertilizer in the world globally (Mangala, 2006). Excessive use of fertilizer can also affect the rice growth and productivity. Application of unbalanced and insufficient fertilizer was not only resulted in low yield but also exploded the soil structure and the soil health (Sharma, Bal & Gupta, 2003). Therefore, nutrition of plant is of great importance and it can be approached appropriately by fertilizer or with the application of plant growth regulators exogenously. In the light of above explained literature that rice productivity was low to achieve the target of the present day demand in the country like Pakistan due to low area and proper management of rice crop nutrition, so this study was planned to determine compatible influence of IAA and NP fertilizer for finding suitable dose which may contribute to maximum yield of rice crop.

MATERIAL AND METHODS

An integrated experiment was performed at the experimental field of Department of Agronomy, Faculty of Agriculture, Dera Ismail Khan during rice cropping season 2016 to investigate the compatible influence of NP (Nitrogen and Phosphorus) fertilizers with the plant growth hormone Indoleacetic acid (IAA). The experiment was laid out in Randomized Complete Block Design with the arrangement of Split plot. The nursery was sown in the month of May and rice seedling was transplanted in June after 35 days of nursery sowing and all recommended agronomic practices was followed at constant level in all plot expect NP fertilizer and application of IAA. NP fertilizer was applied in main plots while the application of Indoleacetic acid was assigned in sub-plots. The extent of subplot was 5 m x 2 m. The details about treatment were given as:

Main factor (NP fertilizer)	Sub-factor (Indoleacetic acid)
NP_1= No application of NP fertilizer	H_1= Nil application of IAA
NP_2= NP fertilizer was applied @ 40 kg ha^{-1}	H_2= 40 ml ha^{-1} of IAA was applied
NP_3= NP fertilizer was applied @ 80 kg ha^{-1}	H_3= 80 ml ha^{-1} of IAA was applied
NP_4= NP fertilizer was applied @ 120 kg ha^{-1}	H_4= 120 ml ha^{-1} of IAA was applied

The NP fertilizers were applied in three splits i.e. at Nursery sowing, at nursery plantation and at flowering stage. Indoleacetic acid was applied in two splits i.e. at tillering stage and at flowering. The crop was well managed and following parameters was registered to study this compatible: plant height (cm), number of panicles $spike^{-1}$, spikelet $spike^{-1}$, number of kernels $spike^{-1}$ and paddy yield of rice (t ha^{-1}) and BCR. These parameters were recorded and analyzed with analysis of variance technique of Steel, Torrie and Dickey (1997) and comparison of means was done through Tukey's HSD Test (Black, 2011).

RESULTS AND DISCUSSION

Plant Height (cm)

The results about plant height are shown in table 1. The fertilizer doses of NP influenced the plant height significantly at 5% level of probability. The rice plants treated with NP_3 (80 kg ha^{-1}) resulted with maximum plant height (145.80 cm) followed by the plants treated with NP_4 (120 kg ha^{-1}) having plant height (136.60 cm). The minimum plant height (111.90 cm) was found in the plants, which were treated with control (No fertilizer). The Indole acetic acid also positively influenced the plant height and also remained significant at $P<0.05$. The maximum plant height (141.00 cm) was achieved by applying the 80 ml of Indole acetic acid as H_3 which is insignificant to 40 ml of Indole acetic acid as H_3 with plant height (132.50 cm). The plant height remained lowest (124.81 cm and 127.30 cm) in control and with highest dose of IAA 120 ml and both insignificant to each other and to H_2. The interactions among doses of Indole acetic acid and fertilizer were also found significant $P<0.05$. The maximum plant height (168.00 cm) was found in the plants where application dose of IAA was 80 ml ha^{-1} and NP was 80 kg ha^{-1} 40 ml as H_2 x 80 kg ha^{-1}.

The least measurement of plants height (107.00 cm) was noticed by control. Yosef (2013) stated that proper doses of NP fertilizer can contribute in the increment of plant height and this is due to accelerated growth by efficient use of NP fertilizer. The plant height was increased by application of IAA and these results are in accordance of Ben and Denial (2017), Dunand (1998) and Subbaih and Mittra (1997) who stated that rice plant height was increased when plant growth hormones was applied exogenously. The increment in plant height was considered because of more vegetative growth by rapid cell division and cell enlargement accelerated by plant growth hormones (Pareek, Jat & Pareek,. 2000). Zahir, Malik and Arshad (1999) reported that artificially applied auxins induced the increment in plant height of rice due to accelerated vegetative growth.

Table 1 Influence of NP levels & IAA on Plant Height (cm) of Rice (*Oryza Sativa* L.)

	H_1	H_2	H_3	H_4	Mean
NP_1	107.00 h	110.50 gh	118.00 f	112.00 g	111.90 c
NP_2	111.70 f	138.00 c	143.00 b	127.00 e	131.30 b
NP_3	137.00 cd	145.00 b	168.00 a	133.00 d	145.80 a
NP_4	138.00 c	136.50 cd	135.00 cd	137.00 cd	136.60 ab
Mean	124.81 b	132.50 ab	141.00 a	127.3 b	

LSD Fertilizers= 9.81
LSD Growth hormones= 13.91
LSD Interactions= 4.90

Number of Panicles (m^{-2})

The results about the number of panicles affected by NP levels and IAA are shown in table 2. The effect of fertilizer dose of NP was seen as significant at 5% level of probability. The plants applied with NP_3 (80 kg ha^{-1}) found to have highest number of panicles (19.88 m^{-2}) followed by the plant applied with NP_4 (120 kg ha^{-1}) having panicles (18.00 m^{-2}). The least number of panicles (14.00 m^{-2}) was achieved by the plants applied with H_1 (Nil application of NP). The number of panicles proved itself significant by applying the different doses of Indole acetic acid (IAA). The plants treated with H_3 (80 ml of IAA) bears maximum number of panicles (20.25 m^{-2}) followed by the plants treated with H_2 (40 ml of IAA) with panicles (17.38 m^{-2}). The plants treated with H_1 (nil application of IAA) scored least number of panicles. The interaction among fertilizer dose and Indole acetic acid dose were also found significant at 5% level of probability.

The plants applied with H_3 (80 ml of IAA) and NP_3 (80 kg ha^{-1}) scored maximum number of panicles (23.00 m^{-2}) followed by the plants treated with H_3 (80 ml of IAA) and NP2 (40 kg ha^{-1}) having number of panicles (21.00 m^{-2}) and minimum number of panicles (10 m^{-2}) achieved by the plants treated with H_1 (Nil application of IAA) and NP_1 (No application of NP). Alam, zaman & Nahar (2009) stated that sufficient supply of Phosphorous can contribute in producing more panicles. Similar type of results was found by Ben and Daniel (2017) who justified that number of panicles could be increased by the application of plant growth hormones. Dakshina, Rao, Vijay and Sridhar (2015) explained that number of panicles and grain yield were significantly affected by fertilizer doses of NPK. The results are in agreement with the results of Rajendra and Jones (2009) who stated that rice plant can posses more panicles by application of plant growth hormones.

Table 2 Influence of NP levels & IAA on number of Rice Panicles (*Oryza sativa* L.)

	H_1	H_2	H_3	H_4	Mean
NP_1	10.00 k	14.00 hj	19.00 f	13.00 ij	14.00 b
NP_2	12.00 jk	16.00 fgh	21.00 ab	17.25 defg	16.56 ab
NP_3	17.0 efg	19.50 bcd	23.00 a	20.00 bc	19.88 a
NP_4	19.00 fg	20.00 bc	18.00 cdef	15.00 ghi	18.00 ab
Mean	14.5 b	17.38 ab	20.25 a	16.31 ab	

LSD Fertilizers= 4.53
LSD Growth hormones= 4.85
LSD Interactions= 2.26

Spikelet Spike^{-1}

The results about spikelet spike^{-1} affected by NP levels and IAA are presented in table 3. The fertilizer doses of NP found as significant at 5% level of probability. Maximum spikelet spike^{-1} (173) achieved by applying NP_3 (80 kg ha^{-1}) followed by NP_4 and NP_2 with spikelets (157.00 and 150.50) respectively, and both these were insignificant to each other. The application of Indole acetic acid on rice plants found significant at $P<0.05$ with respect to spikelet spike^{-1}. The application of H_3 (80 ml of IAA) resulted in scoring maximum (159.00) spikelet spike^{-1} followed by the application of H_4 (120 ml of IAA) having spikelet spike^{-1} (143.80). The least spikelet spike^{-1} (141.30) found by H_1 (Nil application of IAA).

The interactions among fertilizer doses of NP and Indole acetic acid also noticed as significant at 5% level of probability. The most prominent score (186.00) of spikelet spike^{-1} was accessed by applying H_3 (80 ml of IAA) with NP_3 (80 kg ha^{-1}) followed by application of H_2 (40 ml of IAA) with NP_3 (80 kg ha^{-1}) with spikelet spike^{-1} (178.00) and the minimum (94.00) spikelet spike^{-1} obtained by application of H_1 (No application of IAA) along with NP_1 (No application of NP fertilizer). Results are found consoling to Bakhsh *et al.* (2011) who stated that spikelet spike^{-1} can be influenced positively by the application of plant growth regulators.

Table 3 Influence of NP levels & IAA on spikelet spike^{-1} of Rice (*Oryza sativa* L.)

	H_1	**H_2**	**H_3**	**H_4**	**Mean**
NP_1	94.00 k	114.50 j	130.00 f	120.00 j	114.60 c
NP_2	138.00 h	152.00 f	162.00 ab	150.00 fg	150.50 b
NP_3	168.00 c	178.00 b	186.00 a	160.00 de	173.00 a
NP_4	165.00 cd	160.00 de	158.00 cdef	145.00 g	157.00 b
Mean	141.30 c	151.1 b	159.00 a	143.80 c	

LSD Fertilizers= 11.48
LSD Growth hormones= 7.11
LSD Interactions= 5.73

Number of Kernels Spike^{-1}

The results about the impact of NP levels and IAA on the number of kernals are shown in table 4. The effect of fertilizer dose of NP was seen as significant at 5% level of probability. The plants applied with NP_3 (80 kg ha^{-1}) found to have prominent number of kernels (84.69) followed by the plant applied with NP_2 and NP_4 (120 kg ha^{-1}) having number of the kernels (77.50 and 74.00) respectively. The lowest number of panicles (14.00) was achieved by the plants applied with H_1 (No application of NP). The number of kernel was found significant by applying the different doses of plant growth regulator such as Indole acetic acid (IAA). The plants treated with H_3 (80 ml of IAA) bears maximum number of kernel (82.75) followed by the plants treated with H_2 (40 ml of IAA) with number of kernel (77.90). The plants treated with H_1 (No application of IAA) achieved least (69.75) number of kernel.

The interaction among fertilizer and Indole acetic acid dose were found as significant at 5% level of probability. The plants applied with H_3 (80 ml of IAA) and NP_3 (80 kg ha^{-1}) scored highest number of kernels (94.00) followed by the plants treated with H_3 (80 ml of IAA) and NP_2 (40 kg ha^{-1}) having number of kernels (83.75) and minimum number of kernels (58.00) achieved by the plants treated with H_4 (120 ml of IAA) and NP_1 (No application of NP). Similar type of results were found by Islam, Ahmad and Zulfiquar (2005) and Bakhsh, Awan, Sadiq, Niamatullah, Zaman and Aftab (2001) who stated that plant growth hormones played a vital role in producing kernals and it was due to number of growth accelerated by growth regulators.

Table 4 Influence of NP and IAA on Kernels Spike^{-1} of Rice (*Oryza sativa* L.)

	H_1	**H_2**	**H_3**	**H_4**	**Mean**
NP_1	61.00 ij	72.00 h	74.00 gh	58.00 j	66.25 c
NP_2	77.00 efg	78.00 def	81.00 bcd	74.00 gh	77.5 b
NP_3	79.00 cde	83.75 b	94.00 a	82.00 bc	84.69 a
NP_4	62.00 i	75.00 gh	82.00 bc	77.00 efg	74.00 b
Mean	69.75 c	77.9 ab	82.75 a	72.75 bc	

LSD Fertilizers=6.50
LSD Growth hormones=7.60
LSD Interactions= 3.25

1000-Grain Weight (gm)

1000-Grain weight is one of main yield contributing factor paddy grain yield. Therefore, it has great importance for yield accumulation. Results pertaining 1000-grain weight are presented in table-5. NP fertilizers significantly influenced the 1000-grain weight. Maximum 1000-grain weight of 21.90 gm was obtained by applying NP_3 (80 kg ha^{-1}) and was followed by application of NP_4 fertilizer (80 kg ha^{-1}). Minimum 1000-grain weight of 14.75 gm was achieved by control (No application of fertilizer. The effect of Indole acetic acid (IAA) on 1000-grain weight was showed as significant at $P<0.05$. When rice plants applied with H_3 (80 ml of IAA) then maximum 1000-grain weight of 18.72 gram was produced which was followed by the application H_4 (80 ml of IAA) with 1000-grain weight of 18.30 gm and both were insignificant to each other. No application of IAA resulted in minimum 1000-grain weight of 17.00 gm. Their interactions were also found significant.

The plants applied with H_3 (80 ml of IAA) and NP_3 (80 kg ha^{-1}) resulted in maximum 1000-grain weight (23.90 gm) and followed by the plants applied with H_3 (80 ml of IAA) and NP_4 (120 kg ha^{-1}) having 1000-grain weight of 22.90 gm. Poor performance regarding 1000-grain was showed by H_1 (Nil application of IAA) and NP_1 (No application of NP), H_3 (80 ml of IAA) and NP_1 (No application of NP), H_4 (120 ml of IAA) and NP_1 (No application of NP) having 1000-grain weight of 14.40 gm, 140.90 and 14.50 and these are insignificant to each other. Zahir e*t al*. (1999) deduced that there is no significant impact on 1000-grain weight by the application of auxins on rice plants.

These results are in accordance with the Bakhsh *et al.* (2011) and Gurmani *et al.* (2006) in which who claimed that 1000-grain weight of rice was significantly affected when plant growth regulators was applied exogenously.

Table 5 Influence of NP levels & IAA on 1000-Grain Weight of Rice (*Oryza sativa* L.)

	H_1	**H_2**	**H_3**	**H_4**	**Mean**
NP_1	14.40 i	15.20 h	14.90 i	14.50 i	14.75 d
NP_2	16.30 g	17.30 f	16.60 fg	16.60 fg	16.70 c
NP_3	20.20 c	20.60 c	23.90 a	22.90 b	21.90 a
NP_4	17.10 f	18.40 e	19.50 d	19.20 d	18.55 b
Mean	17.00 c	17.85 b	18.72 a	18.30 a	

LSD Fertilizers=1.23
LSD Growth hormones=0.50
LSD Interactions= 0.78

Paddy Yield (ton ha^{-1})

Paddy yield is the function of integrated effect of yield components, which were influenced differently by exo and endogenously conditions. Paddy yield depends upon many factors like number of panicles, number of kernels and grain weight. Results regarding paddy yield are presented in the table 6. Fertilizer doses of NP scored significant difference as shown in Table-5. Fertilizer dose of NP_3 (80 kg ha^{-1}) scored more paddy yield (4.90 t ha^{-1}) followed by NP_4 (120 kg ha^{-1}) with paddy yield (4.50 t ha^{-1}). Minimum score (3.63 t ha^{-1}) of paddy yield was obtained from the plots which were treated with control (No application of NP). Significant results of paddy yield are found with the application of Indole acetic acid. Maximum paddy yield (4.95 t ha^{-1}) was shown by H_3 (80 ml of IAA) followed by H_2 (40 ml of IAA) with paddy yield (4.50 t ha^{-1}). Minimum paddy yield (3.88 t ha^{-1}) was shown by H_1 (no application of IAA). There was noticed a significant difference between the interactions of NP fertilizer and Indoleacetic acid. The plants treated with NP_3 (80 kg ha^{-1}) and H_3 (80 ml of IAA) produced maximum paddy yield (5.80 t ha^{-1}) which was followed by the plants applied with NP_4 (120 kg ha^{-1}) and H_3 (80 ml of IAA) having paddy yield (5.80 t ha^{-1}).

Minimum paddy yield (3.30 t ha^{-1}) was obtained from plant which was treated by H_4 (120 ml of IAA) and NP (No application of NP). Yosef *et al*. (2013) found that proper dose of Nitrogen and Phosphorous can improve the growth and yield of rice. These results are favored by Ben *et al.* (2017), Bakhsh *et al.* (2011), Gurmani *et al.* (2006) and Zahir *et al.* (1999) in which they explained that paddy yield is substantially increased when the rice plants treated with plant hormone exogenously. All yield factors depends on available food energy to produce paddy yield. Numerous attempts to increase one or more of these factors have led to disappointment because often as one factor is increases another will be declined. In this regard, application of synthetic IAA showed better results with application of Nitrogen and phosphorous fertilizer.

Table 6 NP levels Influence & IAA on Paddy Yield (ton ha^{-1}) of Rice (*Oryza sativa* L.)

	H_1	**H_2**	**H_3**	**H_4**	**Mean**
NP_1	3.40 i	3.80 gh	4.00 fg	3.30 i	3.63 c
NP_2	3.60 hi	4.30 ef	4.60 de	3.80 gh	4.08 b
NP_3	4.20 f	5.00 c	5.80 a	4.60 de	4.90 a
NP_4	4.30 ef	4.90 cd	5.40 b	4.70 de	4.70 a
Mean	3.88 c	4.50 b	4.95 a	3.98 bc	

LSD Fertilizers= 0.41
LSD Growth hormones= 0.60
LSD Interactions= 0.30

Benefit Cost Ratio

Benefit cost ratio is important economic analysis which explains the economical credentials of the experiment. The higher value of BCR indicates the more economical treatment in the experiment. Maximum value (4.98) of BCR acquired by fertilizer dose of NP_3 (80 kg ha^{-1}) which was followed by the NP_2 (40 kg ha^{-1}) having BCR of 4.75. Minimum value (4.67) of BCR was showed by NP_4 (120 kg ha^{-1}). It was cleared from economic analysis that the fertilizer dose of NP @ 80 kg ha^{-1} gave more benefit than the others, there it is recommended.

Table7: Benefit Cost Ratio of Fertilizer doses of Nitrogen & Phosphorous applied on Rice (*Oryza sativa* L.)

Fertilizer	BCR
NP_1 (Control)	4.70
NP_2 (40 kg ha^{-1})	4.75
NP_3 (80 kg ha^{-1})	4.98
NP_4(120 kg ha^{-1})	4.67

CONCLUSION

Paddy yield is an integral process of plant hormones and nutrient uptake exogenously and endogenously during growing seasons and cultural practices used to produce rice (*Oryza sativa* L.). It is concluded from the research that application of NP levels and IAA have positive effect on paddy yield and yield contributing factors. It is concluded from our research that application of NP levels and IAA have positive effect on paddy yield, yield contributing factors and economic of Rice. Fertilizer dose of NP_3 (80 kg hac^{-1}) and Indole acetic acid H_3 (80 ml hac^{-1}) recoded best result in each parameter. Hence, application of synthetic growth regulators (IAA) with fertilizers is the best way of obtaining higher yield.

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